USING THE *X*-RAY WITHOUT BURNING.

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Valuable as the *x*-ray is as a therapeutic measure, every operator feels a certain constraint when obliged to use this agent either for therapeutic or diagnostic work. Three years ago a well-known German radiographer formulated certain rules, and gave to the profession a system whereby the *x*-ray effect might be measured, and a certain number of units constituted a safe dose. During the year 1907 this same operator was sued for damages for causing by his own method of dosage severe *x*-ray burns.

All methods of dosage are fallacious because they can not take into consideration the idiosyncrasy of the patient. It is not, therefore, a system of measurement that we require, but rather something that robs the *x*-ray of the element that is most directly responsible for the deleterious effect. Unfortunately, no one has ever been able to see the *x*-rays; we simply have to be content with studying its effects on tissue and chemicals. When chemicals, such as the pearls of Holzknecht, the pastils of Sabouroud or the photographic plates are exposed to the influence of the *x*-ray, certain reasonable measurements might be formulated, because all the elements are more or less known factors and are obliged to respond to certain physical laws.

The principal effect of the *x*-ray on these substances is decomposition of their molecular structure analogous to electrolysis; in other words, a separation of the atoms in the compound, with rearrangement and the formation of new compounds. This effect is primarily due to

two causes: First, to the ionizing power of the *x*-ray; second, to the fact that the charged *x*-ray tube is a converter and surrounded by a static charge, which when separated by a dielectric from a capacity is capable of inducing into that capacity currents of opposite polarity. The current that is in this manner induced into the patient who happens to be the grounded capacity materially assists in the ionizing power of the *x*-ray. We can not deprive the *x*-ray of its ionizing power, but under suitable circumstances we can deprive the tube of its inductive effect by grounding the positive side of the static machine while the tube is in action. When, however, a coil is used for the production of the *x*-ray, neither side of the secondary can be grounded without serious risk of short-circuiting the secondary to the primary, thereby burning out the coil.

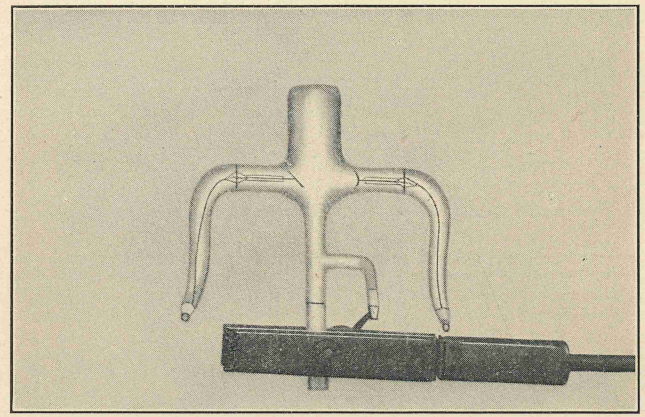

Fig. 1.—The Cornell tube.

This state of affairs caused me to experiment with various shapes of tubes, until two and a half years ago a tube was perfected which I have named the Cornell tube (Fig. 1). This tube is made of heavy lead glass so that no rays are emitted, except through a flint-glass window, which corresponds in size to the lesion to be treated. The connecting wires are encased in glass insulators to prevent sparking on any part of the patient while under treatment. The flint-glass window is situated at the end of a projection, and must be in direct contact with the lesion, thus furnishing a ground and

doing away with the air space which would otherwise be the dielectric between the tube and the patient.

When a tube is brought into direct contact with the patient, only the ionizing effect of the *x*-ray is exerted on the tissues, and this effect is all that is needed to furnish the most brilliant therapeutic results.

During the past two and a half years this system has been used at Cornell Medical College, and in over 5,000 applications not a single case of dermatitis has developed. All cases intended for *x*-ray treatment are divided into two classes, those with broken skin lesions and those where healthy skin covers the lesion.

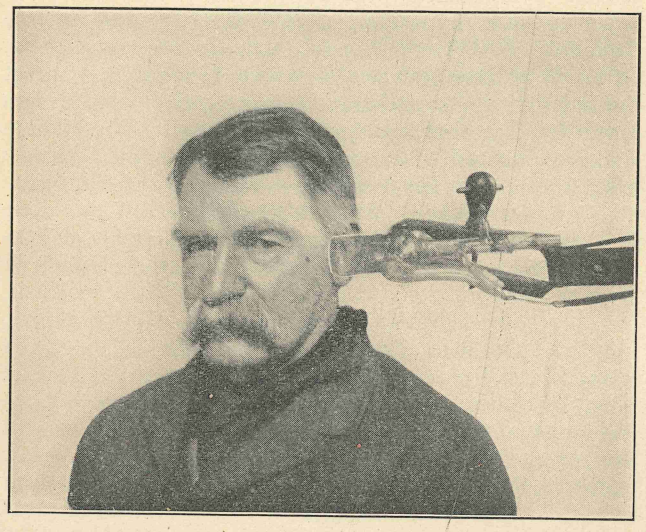

Fig. 2.—Showing manner of using the Cornell tube in localized skin lesions.

In lesions of the first class, or broken skin lesions, we include epithelioma, lupus vulgaris, rodent ulcer, eczema, sycosis, favus, etc. When a patient presents himself for treatment with such a lesion a tube is selected with a window that will as nearly as possible include the entire lesion, the tube is then fastened in the holder in the usual manner and the flint-glass window is applied directly to the lesion for not less than five minutes nor more than fifteen, according to the depth of the pathologic structure (Fig. 2). Within a few hours, and continuing for some days later, a crust will have formed,

and the lesion is reduced in thickness from one-third to one-half; then the same treatment is again repeated. After the fourth or fifth treatment the edges begin to close in. As the lesion becomes smaller the tube is changed to conform to the new size of the old lesion. I have frequently exposed such lesions as epithelioma for thirty minutes during a single seance, yet no burn has ever resulted, neither do I think it possible that a burn could be produced, no matter how long the tube is kept in contact with the skin.

In lesions of the second class, where sound skin intervenes between the lesion and the tube, a slight change in technic is necessary. In this class are included acne, hypertrichosis, hyperidrosis, tubercular glands, splenic leukemia, Hodgkin's disease, itching, dermatoses, etc. In treating these lesions the tube is brought into direct contact with the sound skin, and is slowly moved over a large area, so that the underlying structure receives a sufficient amount of exposure, while the sound skin covering the same receives at any one point but a minimum amount of exposure. With this technic all of this class of lesions are amenable to more or less permanent benefit, yet no burn will result. Whenever such lesions as splenic leukemia, mycosis fungoides, diffuse psoriasis, etc., are to be subjected to the *x*-ray it is preferable to use the tube at a distance of thirty inches, especially when the coil is used as the exciting agent. The tube must, of course, be one with high penetrative power. A dielectric of thirty inches practically removes all the undesirable inductive effect from the tube. When a static machine is used, the positive side of the machine should be grounded, and then the tube may be brought within twelve to fifteen inches of the patient without danger of a dermatitis.

When living tissue is exposed to the influence of the *x*-ray, radium, ultraviolet light, in fact, all radioactive substances, the ionizing property of these substances is felt by the various component parts of each cell. In very mild doses this acts as an irritant and so stimulates the tissue exposed. This accounts for the regrowth of hair or the fact that lanugo frequently takes on active growth, or the pigment cells deposit an extra amount of coloring matter through the exposed area. This has been referred to as the tanning process of the *x*-ray.

A somewhat larger dose, by overstimulation, inhibits

physiologic function, especially all glandular function, and the higher or more complex function, the quicker and more certain the inhibitive action of the ray. Thus the ray will arrest testicular and ovarian function, cause the hair to shed and retard the growth of malignant cell proliferation, especially of glandular origin.

In large doses, meaning thereby prolonged exposures, oft repeated, by complete arrest of function, the ray destroys the nucleus and nucleolus of various cells, those of the horny layer of the skin being most resistant. A cell is dependent on its nucleus for existence; when the nucleus has been destroyed the rest of the cell components, such as the cell membrane and its protoplasm, according to their power of resistance, are either stimulated, inhibited or, like the nucleus, entirely destroyed.

All the parts of cells that are so killed become leukomaines or dead putrid nitrogenous bodies. The system reacts by its chemotactic property, and if this local reaction to this poisonous material is sufficient to cause a visible dermatitis or local inflammation, we have what has erroneously been termed an *x*-ray burn. This is a misnomer and should be removed from the literature. The term radio-dermatitis might be substituted.

The chronic radio-dermatitis of the *x*-ray operators shows all the various changes that the small but oft-repeated doses of *x*-ray are capable of causing. The atrophic areas show the existence of previous inflammation; the dilated blood vessels are the result of the destruction of the intima, while the hyperkeratosis is a compensatory hyperplasia on the part of the economy, due to loss of equilibrium between the various cell elements.

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In the foregoing pages Dr. Geyser has discussed the uses of the *x*-ray along the more advanced methods. I will endeavor to add a few clinical facts coming under my observation during the past eighteen months as physician in charge of the Cornell Clinic.

There are in this clinic twelve different departments, with a total average attendance of 400 patients daily.

This attendance furnished a large material from which to select patients for the *x*-ray department. Each department furnished for *x*-ray treatment only such cases as were not considered suitable for treatment by other methods. For instance, there were no less than nine cases of splenic leukemia under treatment at one time. These cases, for the sake of data, were most closely observed. Dr. Warren, of the department of pathology, regularly subjected these patients to blood examinations and urinalysis to observe any possible untoward effects. No deleterious effects of any kind were noted.

I was interested in the fact that Dr. Geyser claimed to be able to treat these patients without the least danger or thought of dermatitis; yet these patients were exposed to the *x*-ray furnished by a static machine with forty revolving plates, for from twenty to thirty minutes, twice weekly. No burns ever resulted from these exposures, while the spleens markedly decreased in size, and the reports from the pathologic department were more than satisfactory. All manner of obstinate skin lesions were referred to the *x*-ray department, from chronic acne to rodent ulcer and sarcoma. I have repeatedly watched the application of the "Cornell tube" in direct contact with the conjunctiva, yet I never saw the slightest undesirable reaction; on the contrary, the lesions all healed quickly and remained healed. The success was most gratifying in every way, knowing that no untoward results would follow. The process of repair set in immediately, infiltration of surrounding tissue lessened after the first exposure.

In epithelioma the first change noted was lessened hemorrhage from ulcerated surfaces, with a lowering of the granular edges. The most remarkable effect, however, was to be seen in the final results; the sore tissue hardly had the appearance of the usual fibrous variety, but was smooth, soft and elastic, differing but little from the normal skin in the neighborhood.

I was deeply interested in an epithelioma of the chin with glandular involvement. The patient was a man over 60 years of age, the lesion had existed for twenty years and refused to respond to all manner of treatment; plastic operation was considered out of the question, yet this lesion, to my great astonishment and satisfaction, healed completely in one month, or after twelve *x*-ray exposures. This patient wore a full beard and,

strange to say, never lost a single hair during treatment. This lesion has remained well for the past year.

All skin lesions are treated at Cornell by the direct contact method, and no dermatitis ever resulted in consequence of this method. Many patients came to us, who have been under treatment at other institutions, with dermatitis in its various degrees. These were quickly healed and the treatment proceeded as though no previous burn had existed.